PROGRESS REPORT
ON
BITUMINOUS CONCRETE MIXTURE DESIGN
U.S. 52 AT LAFAYETTE

NOV. 1961
NO. 29

Joint Highway Research Project

by

N.G. GAUDETTE
F. MOAVENZADEH

PURDUE UNIVERSITY
LAFAYETTE INDIANA

Progress Report

BITUMINOUS CONCRETE MIXTURE DESIGN
ON U. S. 52 AT LAFAYETTE

TO: K. B. Woods, Director
Joint Highway Research Project

November 8, 1961

FROM: H. L. Michael, Associate Director
Joint Highway Research Project

File: 2-12-5
Project: C-36-55E

Attached is a progress report entitled "Bituminous Concrete Mixture Design on U. S. 52 at Lafayette". This report has been prepared by Messrs. N. G. Gaudette and F. Mavenzadeh formerly and presently, respectively, graduate assistants on our staff. The research reported has been performed under the supervision of Professor W. H. Goetz of our staff.

The research was conducted as a continuance of the attempt to establish a suitable Hveem design procedure to be employed in the design of Indiana bituminous mixtures under heavy traffic conditions. Results of laboratory tests on core specimens taken from a bituminous resurfacing on U. S. 52 at Lafayette, Indiana, and the experience with this surface in the field are reported in this progress report.

The report is submitted to the Board for the record.

Respectfully submitted,

Harold L. Michael
Secretary

HLM:lcm

Attachment

cc: F. L. Ashbaucher
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W. L. Dolch
W. H. Goetz
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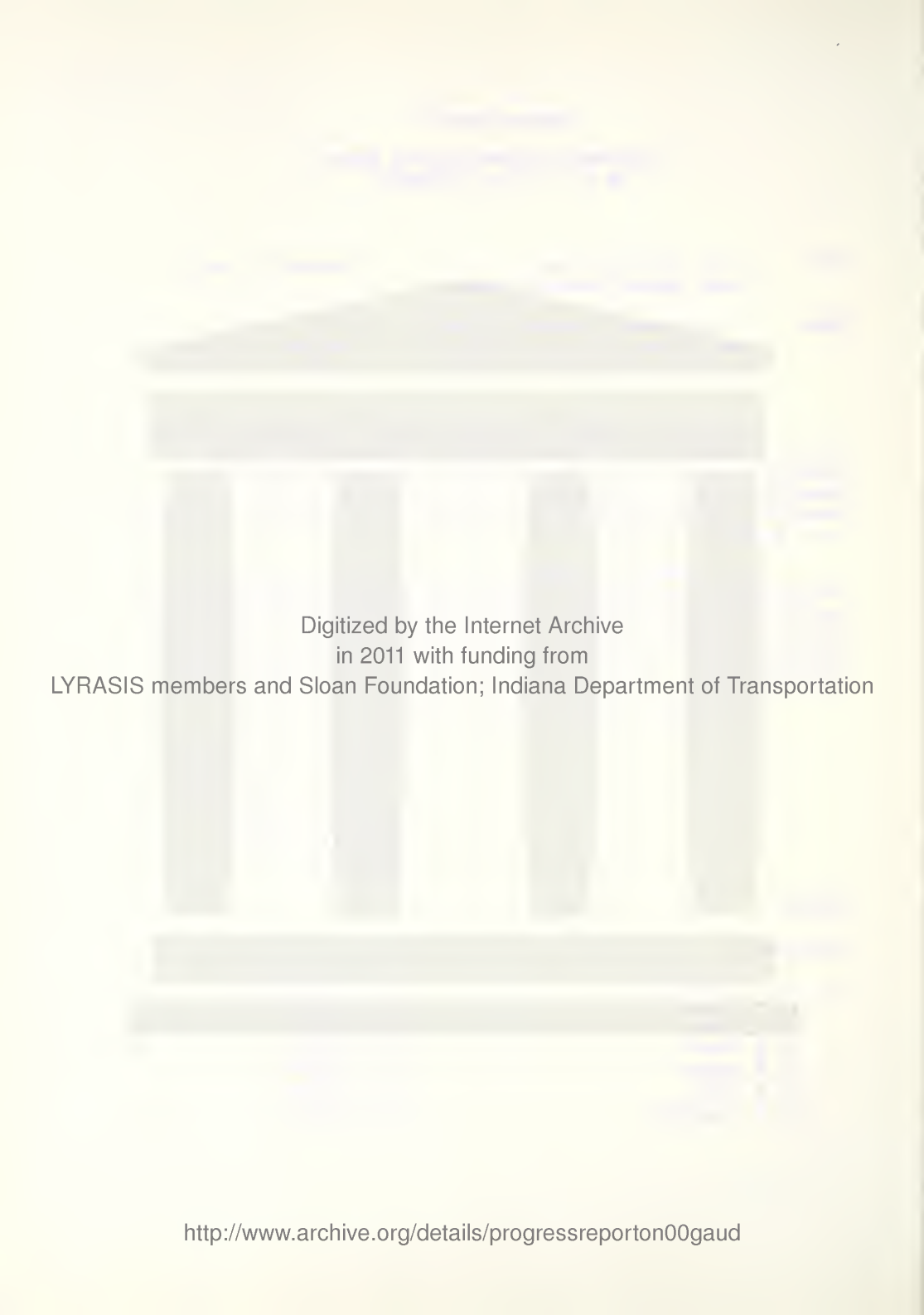

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Progress Report on Bituminous Concrete Mixture Design on U. S. 52 at Lafayette

by

N. G. Gaudette

F. Moavenzadeh

Joint Highway Research Project

Purdue University

Project: C-36-55E
File: 2-12-5

November, 1961

Progress Report on Bituminous Concrete Mixture Design
U. S. 52 at Lafayette

Complete test results of bulk density, rice specific gravity, Hveem stability, and gradation of aggregates, performed in the Joint Highway Research Project Bituminous Laboratory, are reported here for a section of U. S. 52. This section of U. S. 52 is the Lafayette By-pass which was resurfaced in 1956. It consists of 7.335 miles two-lane highway. Resurfacing consists of two binder courses, each 1.1 inches thick and 22 feet wide, and a surface course of .75 inches thick and 22 feet wide. Complete information regarding the type, source and price of materials can be found in the enclosed "Record of Construction".

In continuance of the attempt to establish a suitable Hveem design procedure to be employed in the design of Indiana bituminous mixtures under heavy traffic conditions, a series of core specimens was taken from eleven different sections in the summer 1960. The sections represent different traffic conditions varying from no traffic to heavy traffic areas at intersections. These sections are shown on Figure 1. At each section three positions were selected which were 500 feet apart, and at each position three sets of cores, each including five specimens were taken. On the detailed sketch of each section it can be noticed that one set of cores was taken between wheel tracks and other two in the wheel tracks. These sections are shown in Figures 2 to 10. The equipment used for obtaining cores is pictured in Figure 8 . A 4-in. inside diameter diamond bit was used for drilling.

After drying the samples at room temperature for three days, the composite height of each core was measured. Then the Hveem stability value was determined for each specimen.

Part of the cores were tested as composite samples of binder and surface. For the remainder of the cores the surface and binder layers were separated by cutting at the interface with a masonry saw using a diamond blade. The height of each layer was determined and laboratory tests were performed in the following sequence:

a. Hveem stability on built-up specimens of binder.

b. Bulk density on both surface and binder layers.

c. Rice specific gravity on surface and binder.

d. Percent asphalt content by extraction for binder and surface material.

e. Aggregate gradations for all samples from which asphalt was extracted.

Table 1 presents the layer height, Hveem stability, bulk density, maximum density and percent asphalt content results for surface and binder core samples. The sieve analysis results are presented in Table 2. Table 3 presents test results for specimens formed by recompacting surface and binder samples in the laboratory. Representative samples of the mixtures were used to determine their characteristics with respect to variation in compactive effort. The kneading compactor was used to prepare specimens of 2.5 inches high and 4 inches in diameter using a variable number of tamps. Bulk density and Hveem stability were measured on the specimens so prepared.

A discussion concerning the stability correlation between composite-core samples and built-up surface samples is presented in Appendix A. Tables 1, 2, and 3 of Appendix A contain the test results for this correlation study.

State Highway Commission of Indiana
Department of Operations

RECORD OF CONSTRUCTION

Contract No. RS-4040 Awarded July 3, 1956 Bonded

Location US 52 By-Pass NW Cont. Completed Dec. 4, 56 Proj. Engr. N. Reynolds

ct to SE Jct SR 26 Main St. Amount of Contract for This Road $178,837.05 Inspector R. B. Taylor

ridge to 1st Street

County Tippecanoe Total Work Done: $201,918.36

oad No. 52 Sec. F1 Contractor Fauber Construction Co., Inc.

Awarded-Miles 7.135 Total all Proj. Sys 110,231

Built-Miles 7.335 Total all Proj. Sys. 121,734

CONTRACT COST DATA (Major Items)

Proposal Items	Unit Price	Cost Per Mile	Cost Per Sq. Yd.
Concrete Patches	$1.75	$1,122.61	$0.07
Bituminous Material for Prime	.09	259.24	0.02
Hot Asphaltic Concrete Binder	8.05	12,892.18	0.80
Hot Asphaltic Concrete Surface Type	8.80	6,603.78	0.39
Special Lip Gutter Type "A"	7.45	933.57	
Special Lip Gutter Type "B"	2.45	238.86	
Special Concrete Curb	2.90	253.43	
Combined Curb & Gutter	2.25	571.78	
Cost (All Items) Per Mile		$27,538.06	$1.66

SOURCE OF MATERIALS (Specific Locations)

If material is from different sources show station numbers for each source.

Material	Company	Sources	Station to Station
E 150 Prime	Fauber Constr. Co.	Lafayette, Ind	Total Contract
ggregates	Western Ind. Gravel Co	W. Lafayette, Ind	" "
sphalt Cement Ap)	Alloy Asphalt & Refining Co	Maywood, Ind	" "
ement Type I	Lehigh Cement Co.	Mitchell, Ind	" "

PAVEMENT DATA	First	Second	Third	Fourth
ype of Course	Binder	Binder	Surface	
idth (Feet and Inches)	22'	22'	22'	
rea (SYS.)				
hickness (Inches)	1.1"	1.1"	0.75"	
it. Mat'l (Gals./lbs @ SYD.)	110			
rade and ind of (Prime AE 150 / In Course)	.08/sys			
it. Mat'l. (Seal)	1st			
ggregate Size	#6	#8	#11	
lbs. per SYD	110	110	80	

pecial Remarks:
The above wts. apply to Proj 74 Sec N from Jct. SR 38 to By-Pass Bridge

N. Reynolds [illegible] T. H. Gregory 1-4-57
Engr. or Insp. Date Dist. Engr. Date

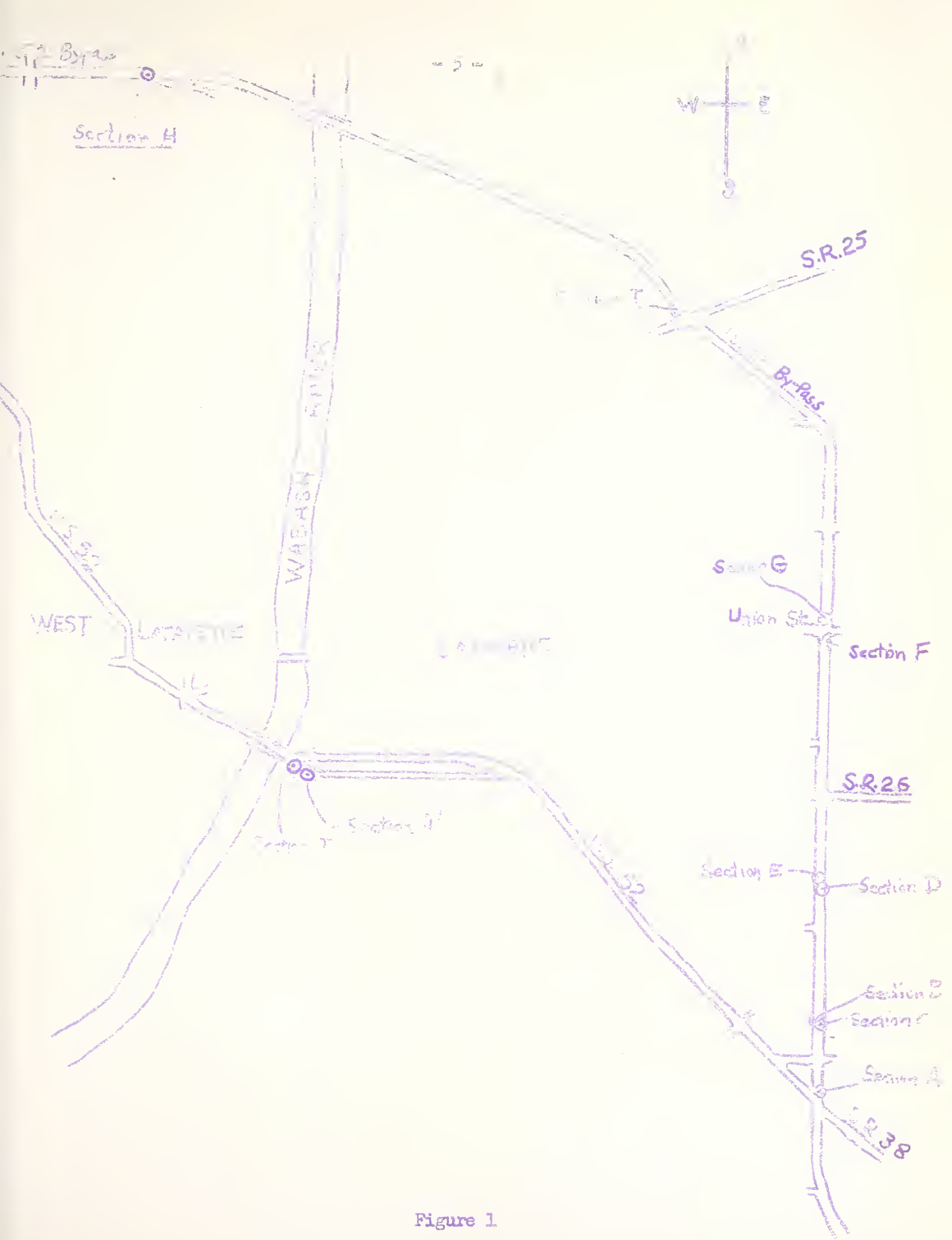
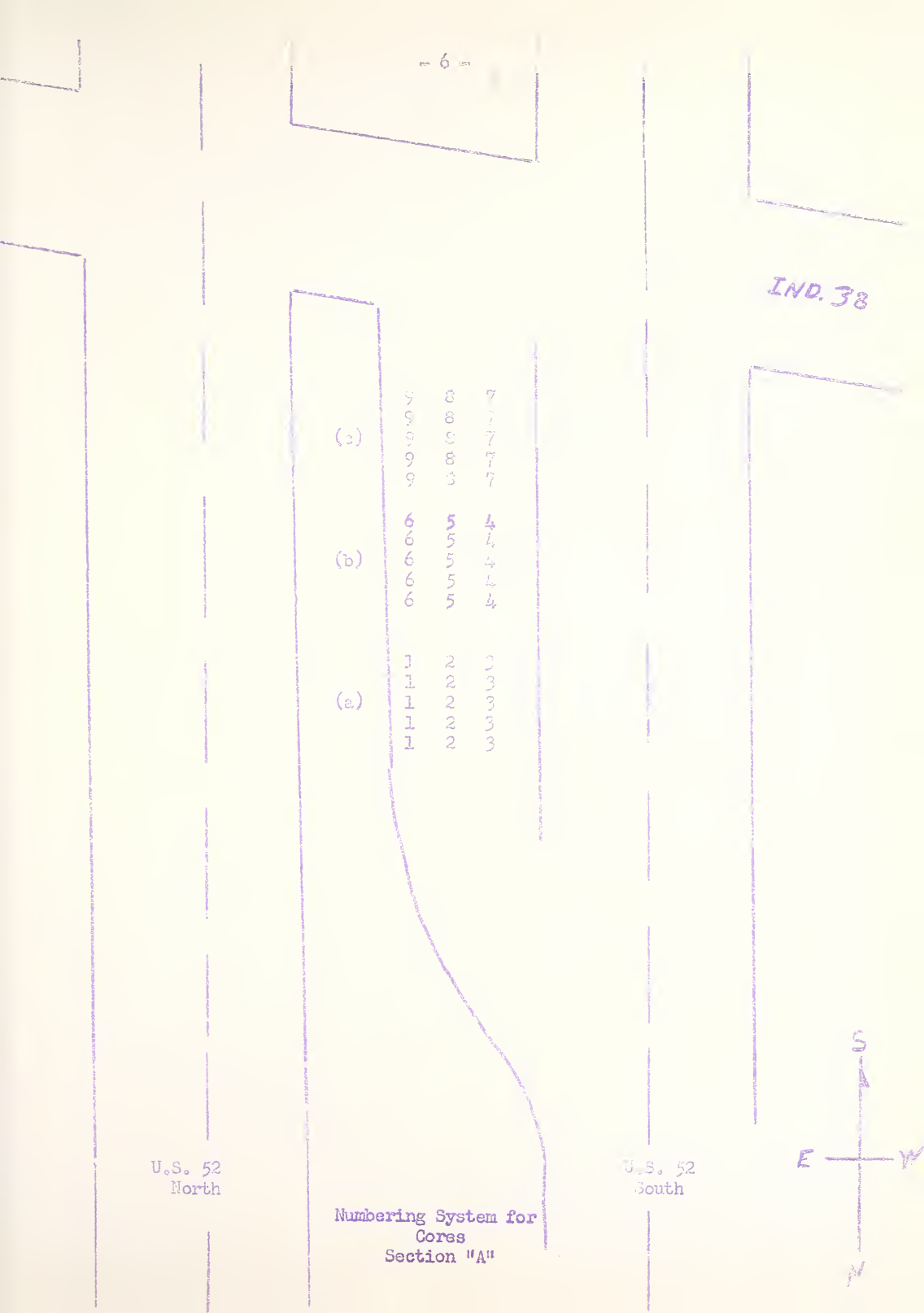


Figure 1

LOCATION OF CORE-SECTIONS

IND. 38



Numbering System for
Cores
Section "A"

Section "A"

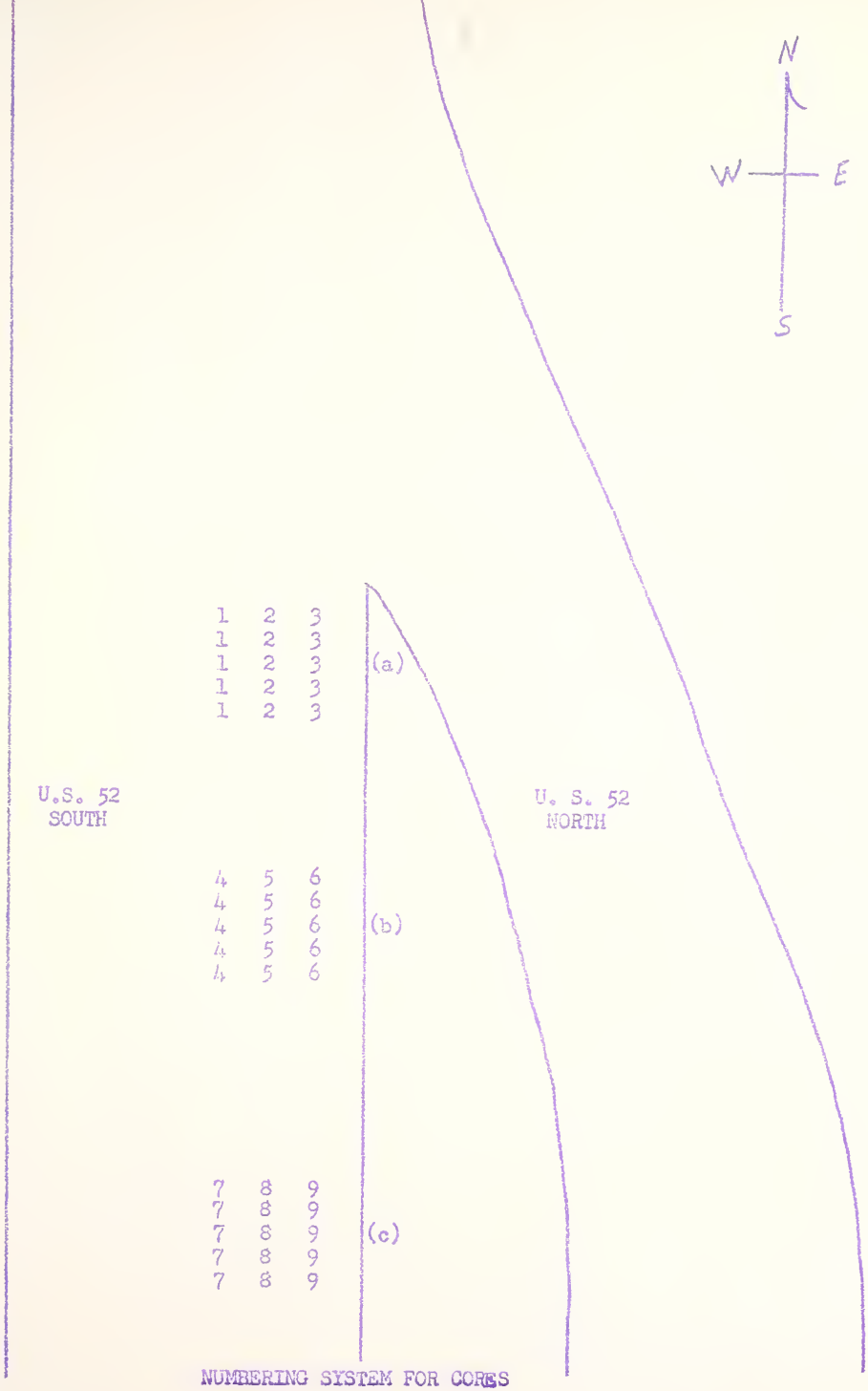
Cores were taken from a section of U.S. 52 where cars pulled over to make a left turn on to State Road 38. There was very little traffic on this section and the cores were taken from the wheel track and "in-between wheel track" part of the section. No transverse or longitudinal rutting or shoving was observed.

This section of pavement should represent very nearly the original pavement conditions since it is so little travelled.

Junction of U.S. 52 South and State Road 38

Section "A"

Fig. 2



NUMBERING SYSTEM FOR CORES

Section "B"

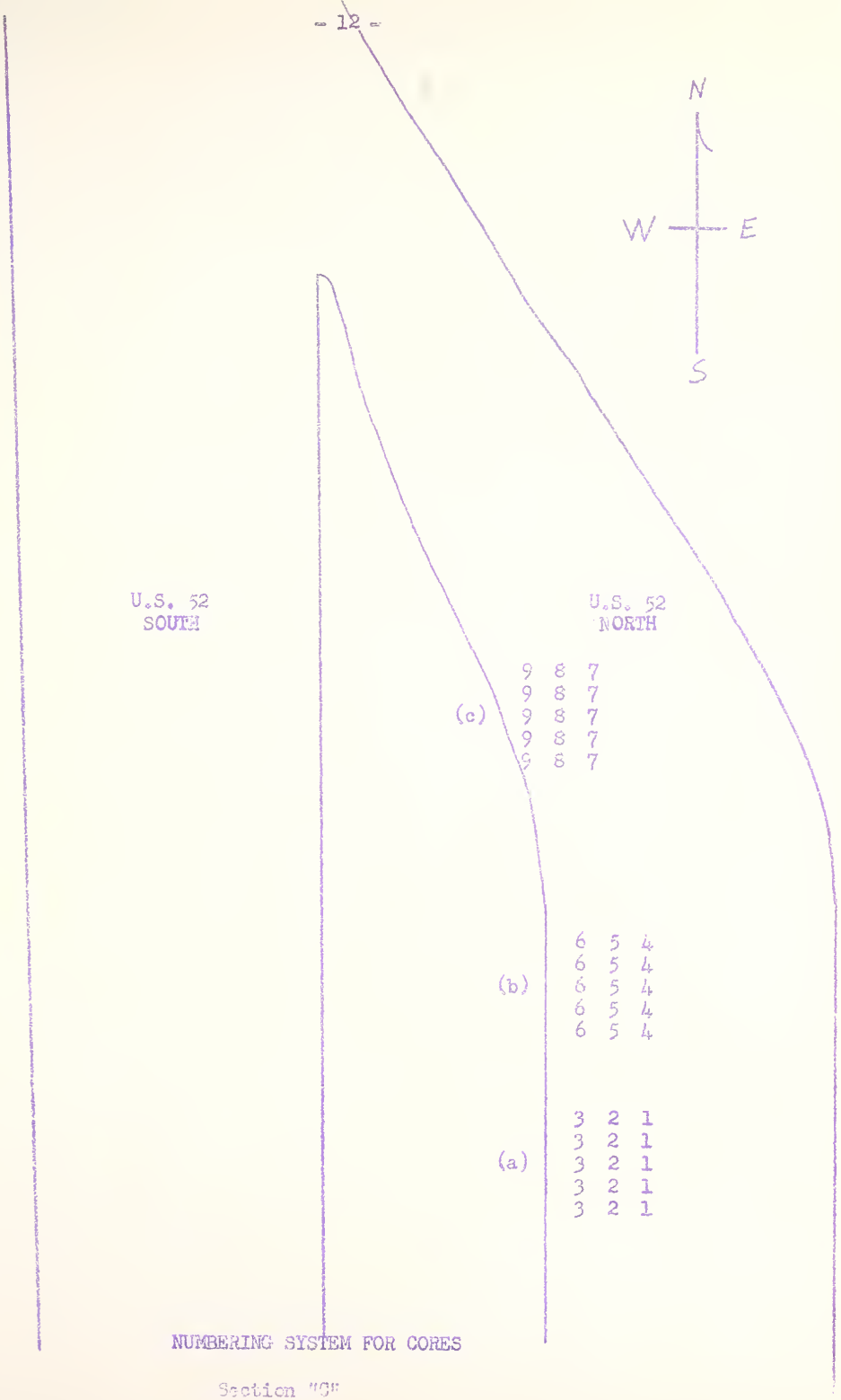
Cores were taken from a section of the highway inside the no-passing line where there should be no traffic at all. No transverse or longitudinal rutting or shoving was observed.

This section should represent original pavement conditions since there has been no traffic on it.

U.S. 52, approximately 1000 feet north of U.S. 52 and State Road 38

Section "B"

Fig. 3



NUMBERING SYSTEM FOR CORES

Section "G"

Section "C"

Cores were taken from a section of the highway inside a no-passing line where there should be no traffic at all. No transverse or longitudinal rutting or shoving was observed.

This section should represent original pavement conditions since there has been no traffic on it.

U.S. 52, approximately 1000 feet north of U.S. 52 and State Road 38 junction

Section "C"

Fig. 4

(a) 3 2 1

(b) 6 5 4

Section "D"

(c) 9 8 7 7 8 9 (c)

4 5 6 (b)

1 2 3 (a)

mal
#2

Egyptian
Lacquer
Company

NUMBERING SYSTEM FOR CORES

SECTIONS "D" & "E"

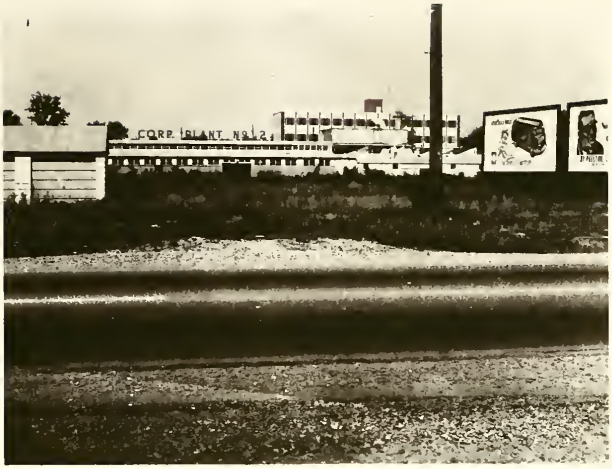
Sections "D" and "E".

On this section of highway there was normal traffic which travelled at approximately 55 mph. Cores were taken from both wheel tracks and from in-between the wheel tracks. No shoving was observed, but there was rutting in all wheel tracks approximately 1/2 inch deep.

U.S. 52 North

Sections "D" and "E"

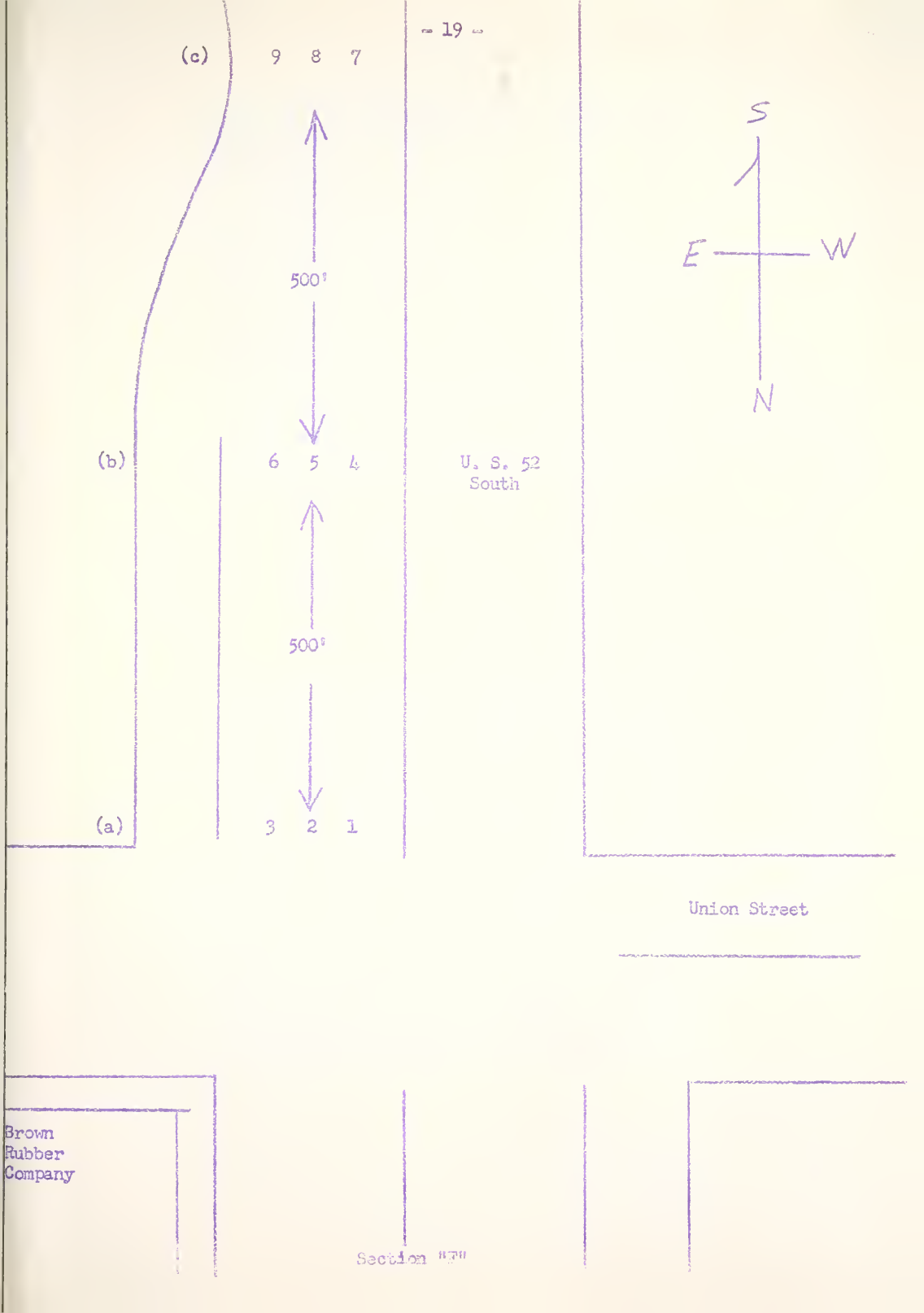
Fig. 5



Cross view of the highway at sections "D" & "E"

Surface structure of the highway at sections "D" and "E"

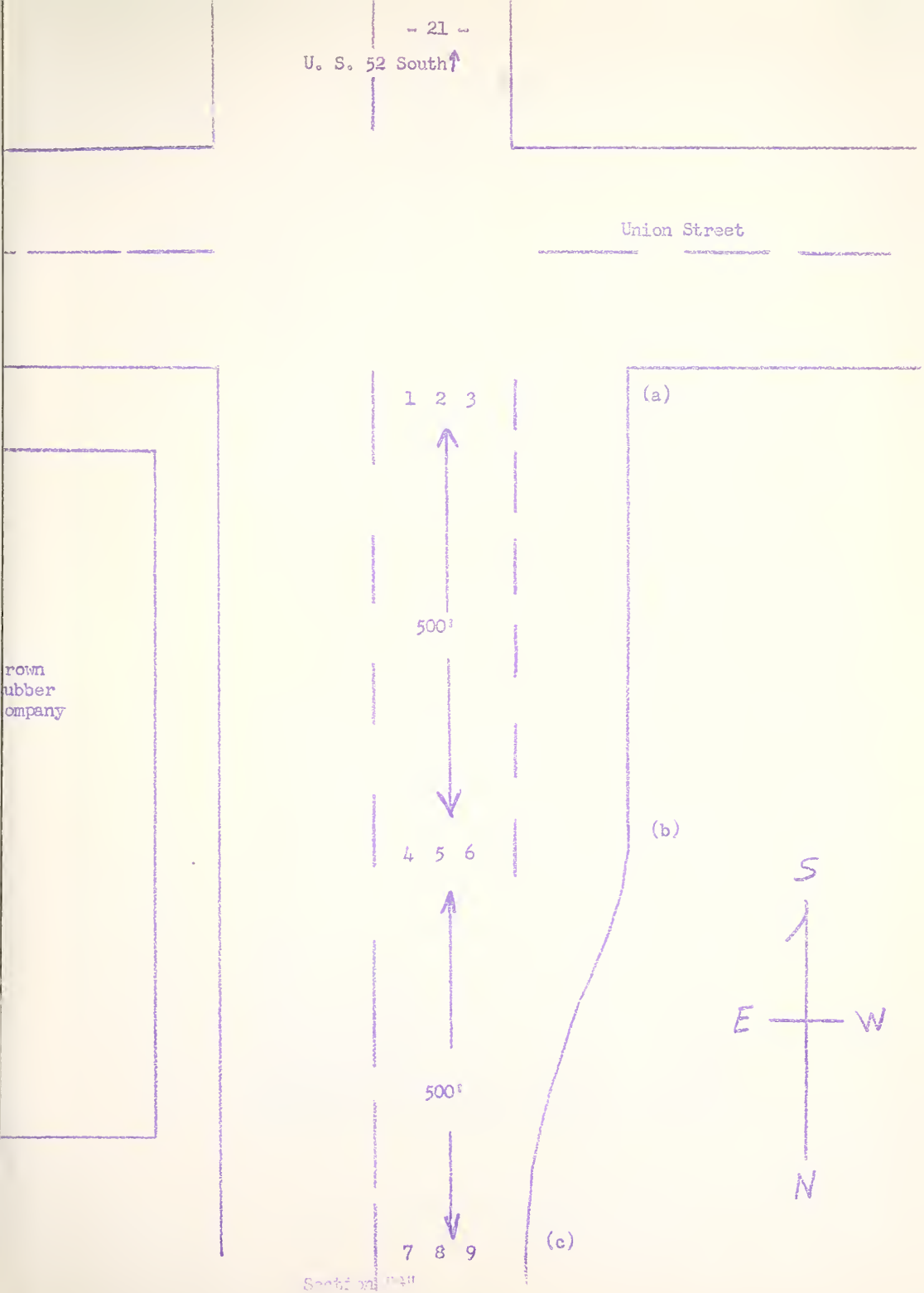
Fig. 6


(c)
9 8 7
500'
(b)
6 5 4
500'
(a)
3 2 1
U. S. 52
South
S
E
W
N
Union Street
Brown
Rubber
Company
Section #70

Cracking and shaving at U.S. 52 & Union Street
Section "F"

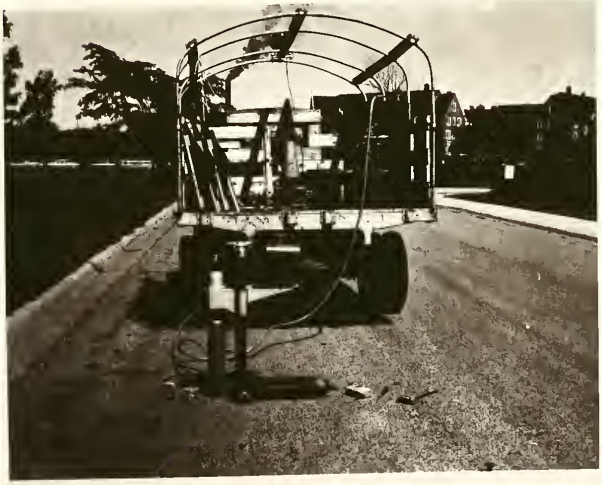
Rutting at U.S. 52 & Union Street
Section "F"

Fig. 7


U. S. 52 South
Union Street
rown
ubber
ompany
1 2 3
500'
4 5 6
500'
7 8 9
(a)
(b)
(c)
S
E
W
N

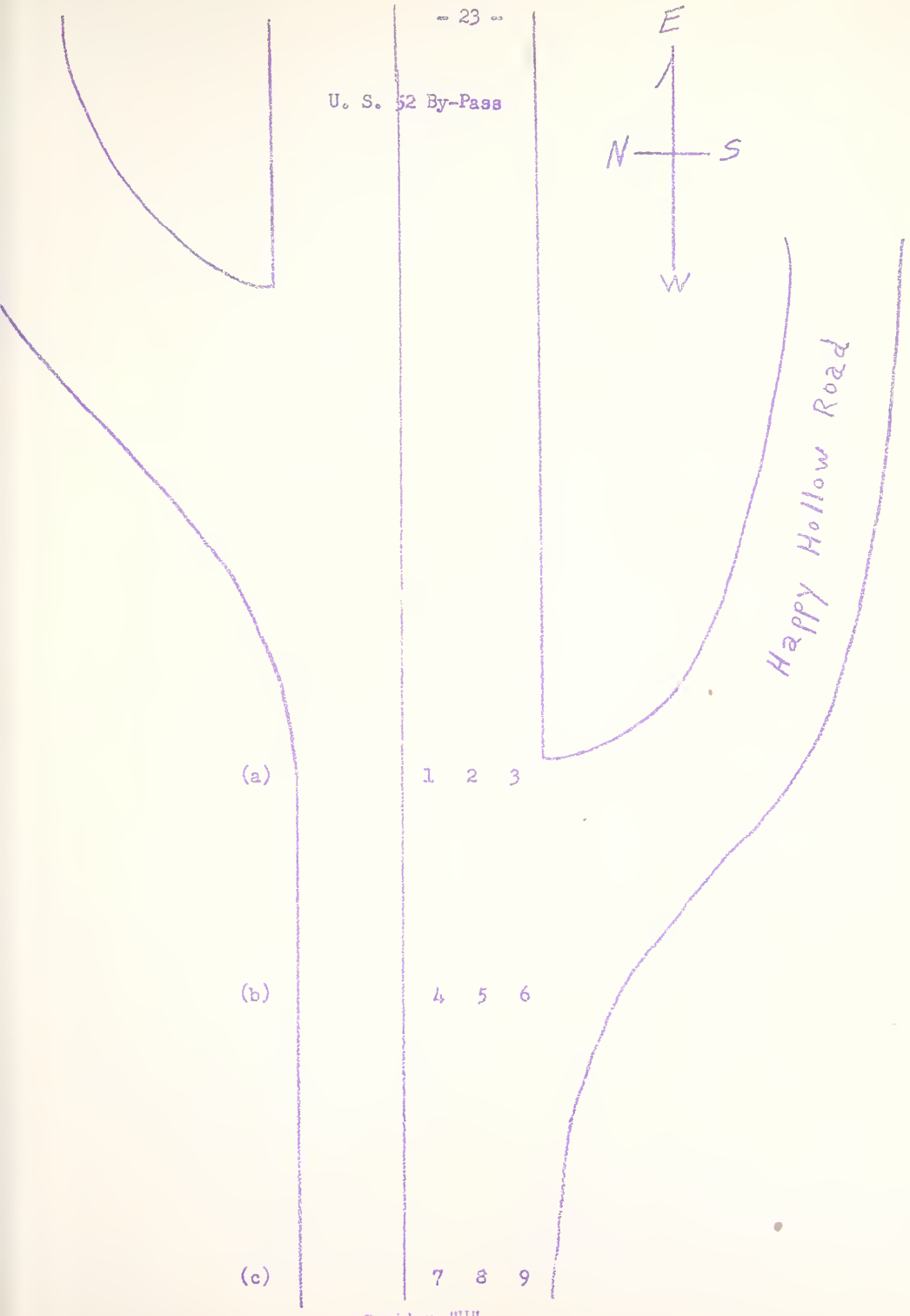
U.S. 52 Bypass at intersection of Union Street

Sections "F" and "G"

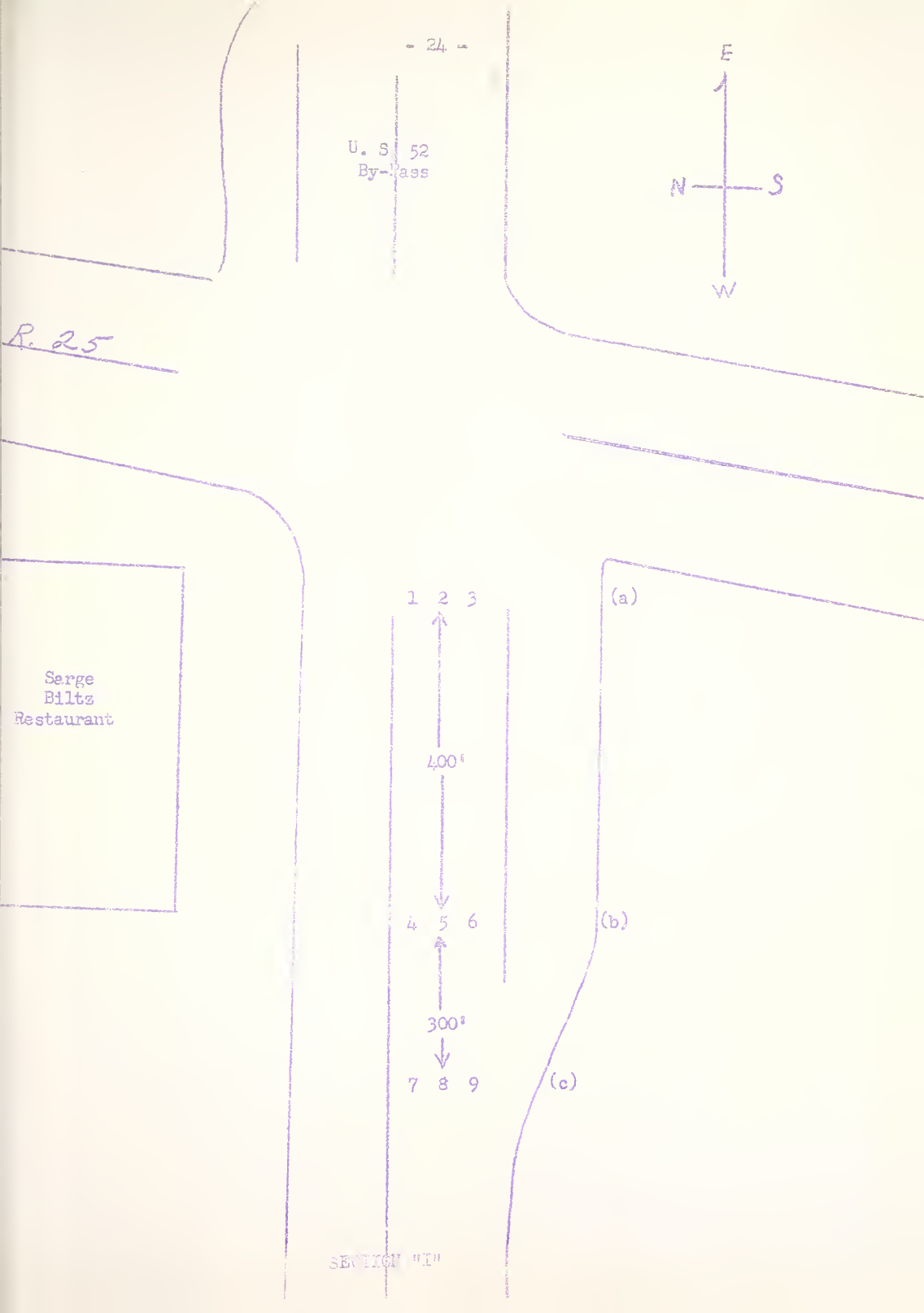


Core drilling Apparatus

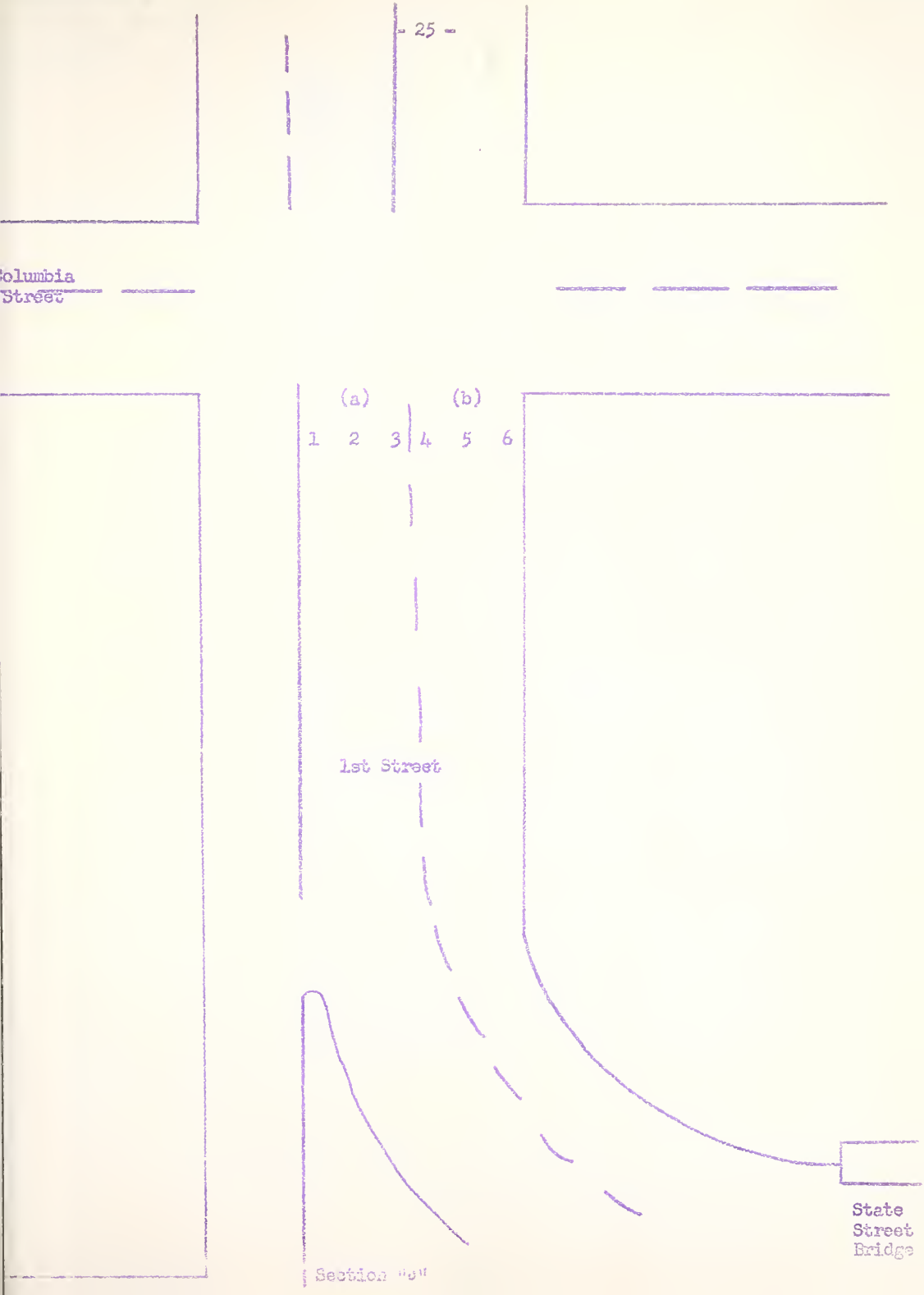
Fig. 8



Section "H"


U. S. 52
By-Pass
E
N
S
W
R. 25
Serge
Biltz
Restaurant
1 2 3
400'
4 5 6
300'
7 8 9
(a)
(b)
(c)

SECTION "I"


Columbia
Street
(a)
(b)
1 2 3 4 5 6
1st Street
State
Street
Bridge
Section "B"

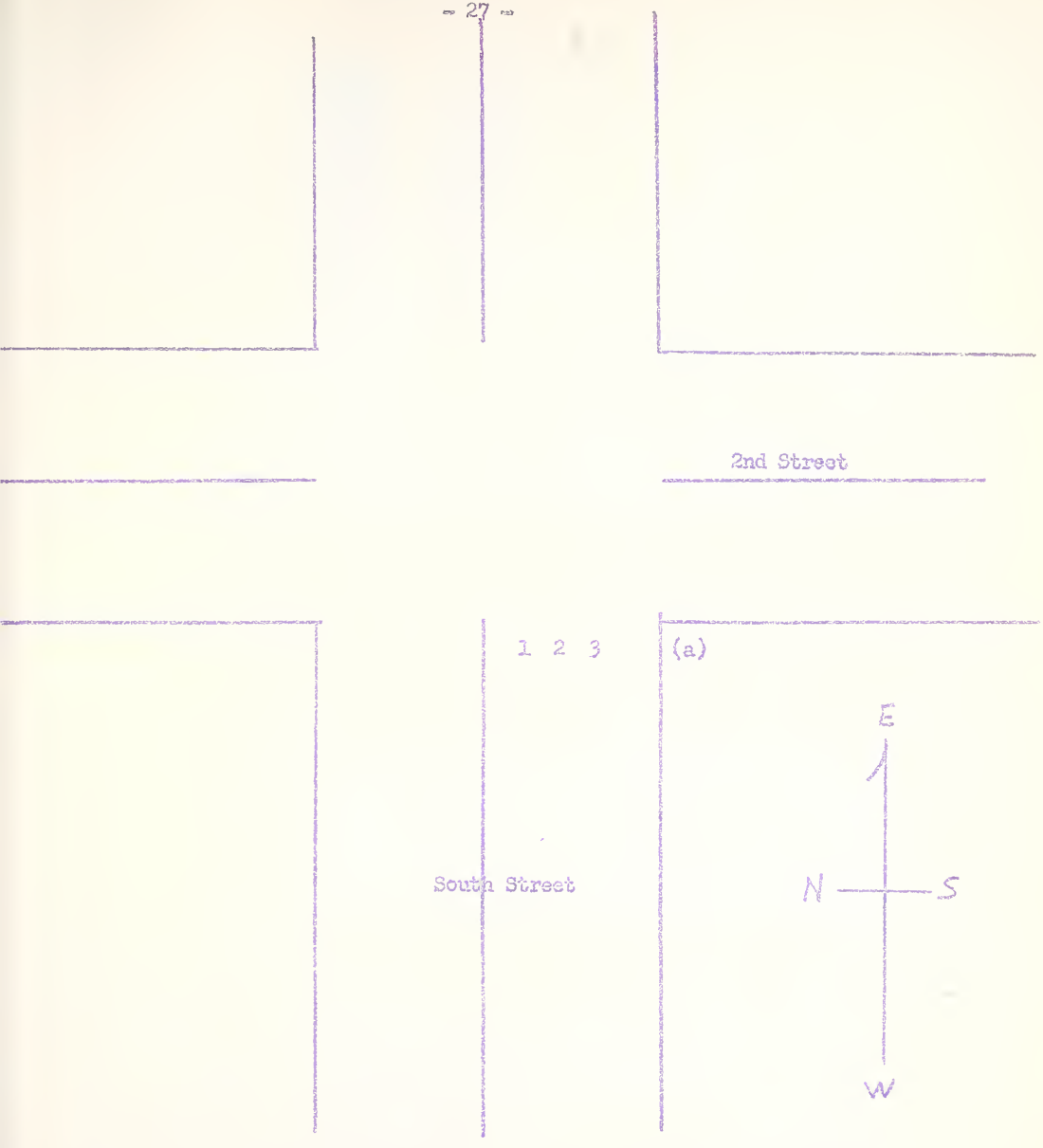
Intersection of 1st & Columbia Sts.

Section "J"

Cores taken in both lanes on 1st Street

Section "J"

Fig. 9



Cores obtained at position "1" only. Others broke apart when bit was lifted. Cohesion very weak.

Section "J'" (Emulsion)

Intersection of South & 2nd Streets

Section "J'"

Cores taken from South Street (Emulsion)

Section "J'"

Fig. 10

TABLE 1

TEST RESULTS ON CORE SAMPLES

Sample Number	Layer Hts., In.		Hveem Stability		Bulk Density, Pcf.		Max. Density lb/ft^3		% Asphalt in Mix	
	Surface	Binder	Composite	Binder	Surface	Binder	Surface	Binder	Surface	Binder
A-1a	0.50	1.84	15.0	15.3	151.9	149.8				
2	0.49	1.88	13.0	19.4	151.8	149.1	153.3	152.5	5.8	5.4
3	0.49	2.08	12.0	17.0	149.3	146.1				
4b	0.51	1.92	14.6	18.7	151.0	146.5				
5	0.49	1.83	15.2	15.3	150.8	148.1	150.1	152.9	6.4	5.0
6	0.44	2.09	15.4	16.6	152.4	149.8				
7c	0.45	1.85	14.3	18.4	150.6	149.5				
8	0.45	1.83	16.8	21.8	151.8	149.5	152.5	152.8	6.0	5.5
9	0.41	1.70	13.4	22.0	152.6	151.3				
B-1a	0.54	2.15	11.0	18.3	149.2	149.2				
2	0.52	2.06	12.8	21.3	150.3	151.8	151.6	153.1	6.0	5.2
3	0.66	1.84	10.7	16.9	150.3	149.3				
4b	0.73	1.73	14.5	20.0	150.8	150.1				
5	0.72	1.82	13.0	19.2	150.1	150.4	154.1	149.6	6.5	5.1
6	0.63	2.03	13.4	20.1	150.3	150.3				
7c	0.69	1.68	15.6	20.5	150.9	149.0				
8	0.69	1.83	14.7	19.4	150.9	149.9	154.2	153.1	6.4	5.8
9	0.57	2.16	14.2	19.1	151.1	150.2				
C-1a	0.48	1.77	14.9	19.3	150.8	148.9				
2	0.47	1.78	13.6	17.2	151.0	149.3	153.4	154.1	6.2	4.8
3	0.42	1.81	12.2	21.3	149.9	148.3				
4b	0.47	2.08	14.6	16.5	151.4	149.1				
5	0.50	2.01	13.8	19.5	149.5	148.4	152.9	152.9	6.5	5.3
6	0.49	1.96	12.7	16.1	150.6	149.6				

TABLE 1 (continued)

Sample Number	Layer Hts., In.		Hveem Stability		Bulk Density, Pcf.		Max. Density lb/ft³		% Asphalt in Mix	
	Surface	Binder	Composite	Binder	Surface	Binder	Surface	Binder	Surface	Binder
7c	0.51	1.93	13.2	15.1	150.4	149.4				
8	0.48	1.92	11.7	13.7	149.7	147.5	151.1	152.3	6.5	5.6
9	0.50	1.90	14.8	19.5	149.9	147.6				
D-1a	0.47	1.70	10.9	18.7	151.4	150.1				
2	0.54	2.34	11.6	14.2	153.5	151.3	154.6	153.9	6.6	5.3
3	0.46	1.91	11.4	16.6	151.4	150.8				
4b	0.45	1.70	11.1	21.2	150.8	150.0				
5	0.53	2.24	11.2	10.7	153.0	150.7	152.1	152.0	6.7	5.5
6	0.41	1.92	15.7	14.3	149.7	150.8				
7c	0.42	1.86	14.5	14.7	152.3	150.5				
8	0.53	2.35	9.8	15.7	153.3	151.5	153.4	153.3	6.4	4.7
9	0.46	2.04	16.0	17.6	152.9	150.4				
E-1a	0.41	2.28	11.1	17.3	149.4	150.3				
2	0.72	2.78	13.4	16.4	153.1	149.8	154.0	152.1	6.8	4.2
3	0.61	2.48	19.8	18.0	151.1	150.2				
4b	0.53	2.29	12.9	15.1	152.4	150.4				
5	0.66	2.74	14.9	19.3	152.6	150.5	154.0	152.0	6.6	4.9
6	0.56	2.54	15.7	19.4	150.3	149.9				
7c	0.59	2.17	15.0	18.1	149.2	149.6				
8	0.72	2.60	12.7	16.2	152.8	149.7	152.8	154.0	6.7	4.5
9	0.62	2.30	15.3	16.9	150.6	150.9				
F-1a	0.15	1.83	6.2	12.4	156.2	151.9				
2	0.36	2.39	12.1	12.0	156.2	150.8	156.0	153.3	5.5	5.6
3	0.25	2.01	2.6	4.1	156.2	151.3				

TABLE 1 (continued)

Sample Number	Layer Hts., In.		Hveem Stability		Bulk Density, Pcf.		Max. Density lb/ft^3		% Asphalt in Mix	
	Surface	Binder	Composite	Binder	Surface	Binder	Surface	Binder	Surface	Binder
4b	0.38	2.05	13.5	19.9	152.4	151.0				
5	0.54	2.59	12.3	13.5	153.5	151.1	153.8	152.7	6.8	4.9
6	0.43	2.25	13.1	13.4	149.4	150.6				
7c	0.44	2.41	10.5	22.7	151.8	151.2				
8	0.55	2.84	13.8	13.9	152.0	150.4	154.8	152.6	6.5	4.7
9	0.44	2.58	16.3	18.7	150.1	150.4				
G-1a	0.24	1.58	9.5	11.8	153.0	150.3				
2	0.54	1.88	9.1	13.3	154.3	149.6	153.9	152.0	7.0	5.1
3	0.25	1.55	12.1	14.5	153.8	150.8				
4b	0.58	1.71	9.2	14.5	153.1	149.6				
5	0.75	2.08	9.7	16.9	153.4	149.8	154.6	153.7	6.7	4.6
6	0.69	1.81	12.1	16.7	152.8	150.8				
7c	0.35	1.42	7.2	8.7	156.7	150.4				
8	0.67	1.87	14.9	16.4	156.2	150.8	157.5	154.4	5.9	5.0
9	0.61	1.73	12.5	19.5	156.9	151.1				
H-1a	0.81	2.10	9.4	14.9	151.9	150.8				
2	0.91	2.12	14.7	20.4	153.8	151.6	153.2	151.8	6.8	5.5
3	0.83	2.01	12.3	19.5	151.9	151.3				
4b	0.81	1.84	13.5	12.6	151.8	151.6				
5	0.92	1.86	8.1	22.2	153.0	151.1	153.5	153.6	6.8	5.1
6	0.89	1.71	11.7	21.7	152.6	151.6				
7c	0.88	2.04	9.4	12.6	150.1	148.9				
8	0.96	2.08	2.9	8.1	153.5	150.5	153.1	152.2	7.0	5.8
9	0.89	2.01	9.3	11.7	152.3	149.7				

TABLE 1 (continued)

Sample Number	Layer Hts., In.		Hveem Stability		Bulk Density, Pcf.		Max. Density lb/ft³		% Asphalt in Mix	
	Surface	Binder	Composite	Binder	Surface	Binder	Surface	Binder	Surface	Binder
I-1a	0.52	1.65	14.3	14.0	153.8	151.4				
2	0.41	1.79	15.8	18.6	154.6	152.1	158.5	154.6	5.5	4.8
3	0.50	1.74	13.0	18.0	157.6	151.7				
4b	0.53	1.58	14.6	16.6	151.1	150.3				
5	0.55	1.91	14.7	15.9	157.0	150.3	155.3	153.8	5.6	5.5
6	0.38	1.62	15.5	18.8	153.6	151.0				
7c	0.57	1.66	10.6	15.6	151.0	149.7				
8	0.57	2.01	8.2	14.8	154.2	149.4	154.6	153.1	6.7	4.7
9	0.45	1.67	14.1	20.1	152.4	150.6				
J-1a	0.72	1.99	11.0	15.1	154.3	153.6				
2	1.06	2.66	8.9	17.0	152.9	153.0	158.1	156.2	5.6	5.9
3	0.97	2.32	9.5	---	154.0	154.1				
4b	0.46	1.43	7.5	---	153.7	152.4				
5	0.48	1.72	19.4	12.2	154.9	152.7	156.5	155.3	5.9	4.8
6	0.18	2.65	14.5	20.3	155.3	150.5				
J[1]-1a	0.65	2.30	13.2 & 10.7	25.3	145.1	146.7				
2	0.68	2.30	---	---	---	---	156.1	156.7	3.9	3.9
3	0.62	2.07	---	---	147.2	150.1				

TABLE 2

SIEVE ANALYSIS DATA (a)
(Percent between sieves)

Sieve Size	Sample No. (Surface) A-a	A-b	A-c	B-a	B-b	B-c	C-a	C-b	C-c
1/2 in. - 3/8 in.	7	5		9	5	6	7	7	7
3/8 in. - No. 4	34	32		33	33	30	32	32	32
No. 4 - No. 6	11	11		12	12	12	11	11	11
No. 6 - No. 8	7	8		7	8	8	7	7	7
No. 8 - No. 16	9	10		9	10	9	9	10	9
No. 16 - No. 50	20	20		19	21	21	21	20	21
No. 50 - No. 100	5	5		5	5	5	5	6	5
No. 100 - No. 200	3	3		3	3	3	3	3	3
No. 200 -	4	3		4	3	4	5	4	4

	(Binder)								
1 in. - 1/2 in.	18	13	11	16	13	12	30	21	19
1/2 in. - No. 4	41	47	48	45	46	47	41	40	43
No. 4 - No. 6	4	5	4	5	6	5	3	5	5
No. 6 - No. 8	4	4	4	5	5	5	2	4	4
No. 8 - No. 16	7	7	8	8	8	8	5	7	7
No. 16 - No. 50	17	17	16	17	16	17	13	16	16
No. 50 - No. 100	4	4	5	4	4	4	3	4	4
No. 100 - No. 200	2	2	1	2	2	2	1	1	2
No. 200 -	2	1	2	2	2	2	2	2	2

(a) These are dry gradations of aggregate samples weighing approximately 1000 gms after extraction. Each sample was sieved through a nest of standard 8-in. sieves using a mechanical shaker for approximately 7 minutes.

TABLE 2 (continued)

Sieve Size	Sample No (Surface) D-a	D-b	D-c	E-a	E-b	E-c	F-a	F-b	F-G
1/2 in. - 3/8 in.	8	10	10	8	10	7	3	4	7
3/8 in. - No. 4	30	30	27	29	28	31	33	30	32
No. 4 - No. 6	10	10	10	11	10	10	12	11	10
No. 6 - No. 8	8	8	8	8	8	8	8	9	8
No. 8 - No. 16	11	10	11	10	12	11	11	13	10
No. 16 - No. 50	22	22	22	23	21	23	21	21	22
No. 50 - No. 100	5	7	5	6	4	4	5	5	5
No. 100 - No. 200	2	2	3	2	3	3	2	4	3
No. 200 -	4	4	4	4	4	4	4	5	4

	(Dinner)								
1 in. - 1/2 in.	19	22	22	22	18	22	17	22	24
1/2 in. - No. 4	45	43	44	49	46	45	44	43	44
No. 4 - No. 6	3	3	2	3	4	4	4	4	3
No. 6 - No. 8	3	3	3	2	3	3	4	4	3
No. 8 - No. 16	6	7	6	4	6	5	7	7	6
No. 16 - No. 50	10	15	14	13	14	13	16	15	14
No. 50 - No. 100	4	3	3	4	4	4	3	3	4
No. 100 - No. 200	2	1	1	2	2	2	2	1	1
No. 200 -	2	3	3	2	2	2	4	2	2

TABLE 2 (continued)

Sieve Size	Sample No. (Surface) G-a	G-b	G-c	H-a	H-b	H-c	I-a	I-b	I-c
1/2 in. - 3/8 in.	7	9	9	7	7	6	6	11	14
3/8 in. - No. 4	28	34	29	31	30	30	34	31	30
No. 4 - No. 6	11	10	12	10	11	11	12	11	9
No. 6 - No. 8	7	7	9	7	7	8	9	7	6
No. 8 - No. 16	11	10	10	11	10	11	12	9	10
No. 16 - No. 50	22	21	19	20	24	24	18	20	20
No. 50 - No. 100	5	4	3	5	5	5	4	5	5
No. 100 - No. 200	3	2	3	3	2	2	2	3	3
No. 200 -	4	4	5	4	3	3	4	4	4
(Binder)									
1 in. - 1/2 in.	17	26	17	23	22	21	22	16	20
1/2 in. - No. 4	43	43	45	35	41	40	46	47	44
No. 4 - No. 6	3	4	5	3	3	5	3	5	4
No. 6 - No. 8	3	3	4	4	3	4	3	4	3
No. 8 - No. 16	6	5	7	6	7	8	6	6	6
No. 16 - No. 50	15	14	15	23	16	15	14	16	16
No. 50 - No. 100	4	3	4	3	4	4	4	3	4
No. 100 - No. 200	2	1	2	1	2	1	1	2	2
No. 200 -	2	2	2	2	2	2	2	2	2

TABLE 2 (continued)

Sieve Size	Sample No. (Surface)		
	J-a	J-b	J-c
1/2 in. - 3/8 in.	5	8	9
3/8 in. - No. 4	30	32	32
No. 4 - No. [illegible]	32	32	32
No. 6 - No. [illegible]	8	8	6
No. 8 - No. [illegible]	12	12	7
No. 16 - No. 30	21	20	13
No. 50 - No. 100	4	4	4
No. 100 - No. 200	4	4	3
No. 200	3	2	2

(Binder)

1 in. - 1/2 in.	33	30	28
1/2 in. - No. 4	37	39	44
No. 4 - No. 8	4	3	2
No. 6 - No. [illegible]	3	3	2
No. 8 - No. 16	6	6	5
No. 16 - No. 50	13	14	13
No. 50 - No. 100	3	4	2
No. 100 - No. 200	2	1	1
No. 200 -	3	2	1

TABLE 3

RECOMPACTED PAVEMENT TEST RESULTS

Recompacted Surface

Sample Section(s)	Compaction Time @ 500 psi Min.	Bulk Density, PCF	Hveem Stability
A*	5	153.7	7.4
B	5	153.8	11.5
E	5	153.8	1.7
F	5	153.8	1.4
G	5	154.9	3.1
H	5	153.4	1.1
I	5	154.0	6.5
J-a (No. 1)	5	153.2	23.4
J-a (No. 2)	5	151.6	5.4
A-a	5	150.6	---
A-b	5	149.9	---
A-c	5	150.3	---
AEFGHJ**	0***	149.9	22.9
AEFGHJ	1.5	152.9	26.6
AEFGHJ	3	153.4	13.4
AEFGHJ	5	153.8	10.3

* Samples A through J-a (No. 2) are composed of approximately equal amounts of material from positions a, b and c.

** Approximately equal amounts of material from each section

*** Seating load only applied.

TABLE 3. (CONTINUED)

RECOMPACTED PAVEMENT TEST RESULTS

Recompacted Pavement

Sample Section(s)	Compaction Time @ 500 psi Min.	Bulk Density, pcf	Hveem Stability
A-a	5*	—	5.6
A-b		—	3.1
A-c		—	2.1
C-a		[illegible]	1.0
D-b		[illegible]	6.8
E-a		[illegible]	—
F-b (No. 1)		151.[illegible]	0
F-b (No. 2)		151.6	7.4
F-c		151.9	8.7
G-a		151.[illegible]	12.0
G-b		150.9	44.3
G-c		150.[illegible]	36.3
H-a		151.2	26.7
I-a		151.1	33.4
I-c		150.9	41.8
J-a	V	152.4	48.1
J-b	5	150.6	33.9

* Standard Compaction used for all Specimens

Results and Conclusions

The findings of this study can be summarized as follows:

1. Generally, increase in traffic intensity has resulted in increase in the bulk density of the surface material. The range of this variation is from 149.3 lb. per cubic foot at section B with practically no traffic to 156.2 lb. per cubic foot at section F-a which is in a stopping area near an intersection.

2. Bulk density of the binder course was not greatly affected by change in traffic intensity, but there was tendency toward higher density with increase in traffic intensity.

3. The asphalt content of the by-pass surface course varied from 5.5 to 7.0 percent. Variation in the asphalt content of binder was 4.2 to 5.8 percent.

4. The maximum densities of both binder and surface courses increased with decrease in asphalt content and vice versa.

5. Hveem stability values both for composite and binder samples were much less than 35, which is specified as a minimum stability in California for laboratory compacted mixtures to be subjected to this type of high-volume traffic.

6. Generally, Hveem stability was low when bulk density was high. A good example is section F, location a, where the bulk density was 156.2 lb. per cubic foot and the stability value was about 6.0. This is in agreement with the laboratory studies made on recompacted specimens.

7. Hveem stability values decreased as asphalt content increased. This trend was more significant for the binder course where density did not vary greatly.

8. Data from wheeltrack and between wheel tracks did not show any specific pattern to indicate a difference between these two positions. This result can be attributed to the generally failed condition of the pavement at the time of sampling.

As has been mentioned previously, this coring was done four years after the construction was completed. During the coring process much shoving and rutting was observed in traffic areas as can be seen in pictures of sections, Figures 2 to 10. This rutting and shoving indicated that much of the pavement had failed during four years of service, and that plastic flow of the pavement had obscured the effect of more intensive loading in the wheel tracks. This has resulted in randomness of the results from this standpoint.

In evaluating the laboratory test results in this study it is important to view the data as an attempt to simulate the field condition of the pavement after four years of service by varying compactive effort. No attempt was made to establish the most suitable asphalt content by the Hveem design procedure, and it should be realized that compactive effort was changed only by changing the number of kneading tamps.

Generally the data show that as the compaction effort increased the density of the surface material increased, but stability approached a maximum and then decreased. Of course it has to be mentioned that the data are not sufficient and the range of variation of compactive effort is not wide enough to generalize this statement.

It can be noticed that the standard compaction pressure of 500 psi and 5 minute tamping has resulted in very low values for Hveem stability and high values for density of the surface course. The density values obtained under standard compaction procedure were very close to maximum

density which resulted in almost zero percent voids. These laboratory test results indicate that the mixture would not pass the standard Hveem stability and voids requirements commonly specified for design in California. However, by comparing these results with the Hveem stability values obtained from field specimens, it can be seen that the latter generally have higher stability and lower density values, which necessitates the selection of a lower compactive effort for this mixture in order to obtain better agreement between field and laboratory test results for density, Hveem stability and voids. For the binder material, standard Hveem compaction procedure has produced higher values for stability than were obtained on field specimens. Density values on the binder mixture were nearly equal for standard laboratory compacted and field specimens. This possibly indicates that for binder material standard compaction procedure is a close approximation to the field condition.

The results of sieve analysis on surface and binder samples are shown in Table 2. These data indicate that the gradations of aggregate for both surface and binder correspond with Indiana Specifications.

APPENDIX A

The results indicate that a strength value for the surface can be obtained by testing a composite core, and the value will not be significantly different from that obtained using a built-up specimen composed entirely of surface material. This eliminates the need for taking so many cores and makes the preparation of each specimen a considerably quicker and less time consuming.

performed, two and three layer specimens [illegible] stability result.

These results, as those for the [illegible] applicable only to the particular [illegible] studied here.

Table I

Surface Test Data

Surface (composite [illegible])

Vertical Load, lbs	Specimen No 3	4	5	7	8	9
			Lateral Pressure, psi			
500	12	15	14	[illegible]	[illegible]	12
1000	19	[illegible]	22	[illegible]	[illegible]	20
2000	38	[illegible]	43	[illegible]	[illegible]	39
3000	62	69	68	71	70	65
4000	90	97	96	100	101	94
5000	122	127	126	133	134	128
6000	154	159	160	166	169	163
D	2.90	2.86	3.01	2.9[illegible]	[illegible].32	3.25
S	14.8	14.6	13.8	13.2	12.7	12.7
Ht, in.	2.40	2.44	2.32	2.51	2.49	2.46
Eff Ht, in	2.4	2.4	2.4	2.4	2.4	2.4

[illegible] (built-up)

Vertical Load, lbs	Specimen No. 4	5	7	8	9
			Lateral Pressure, psi		
500	8	[illegible]	7	9	7
1000	14	10	13	14	12
2000	32	21	27	34	29
3000	56	48	48	60	54
4000	88	72	74	94	82
5000	122	103	104	128	116
6000	166	138	138	166	152
D	3.02	3.57	2.93	3.35	3.65
S	14.4	15.2	14.6	12.7	13.1
Ht, in.	2.39	2.46	2.20	2.44	2.61
Eff Ht, in	2.4	2.4	2.2	2.4	2.6
No. layers	4	4	3	4	4

Table 2

Triaxial Test Data

Hinsdale (surface pre-tested)

Vertical Load, lbs	Specimen No. 4	5	7	8	9
	Lateral Pressure, psi				
500	12	12	13	12	12
1000	16	18	20	16	18
2000	32	31	36	30	32
3000	51	47	55	46	47
4000	73	66	77	68	67
5000	98	86	100	90	90
6000	124	110	130	117	117
D	3.12	3.13	3.13	3.55	3.73
S	18.0	19.6	17.5	17.7	17.0
Ht, in.	2.32	2.38	2.34	2.27	2.29
Eff Ht, in	2.4	2.4	2.4	2.4	2.4
1/2" layer on top		bottom	bottom	top	bottom

Barker (surface pre-tested)

Vertical Load, lbs	Specimen No. 3	4	5	6
	Lateral Pressure, psi			
500	10	10	12	12
1000	13	13	18	15
2000	21	21	22	16
3000	32	30	37	30
4000	48	50	56	56
5000	66	71	78	77
6000	88	93	103	102
D	3.01	3.01	3.28	3.20
S	27.2	25.5	21.8	22.5
Ht, in.	2.35	2.38	2.38	2.38
Eff Ht, in	2.4	2.4	2.4	2.4
1/2" layer on bottom		top	(top - 3 layer)bottom	

Table 3

Summary of Stability Correlation Results

	Hveem Stability			
	Surface		Binder	
	Composite Core	Built-up	Surface Not Tested	Surface Pre-tested
	14.8	14.4	18.0	27.2
	14.6	15.2	19.6	25.5
	13.8	14.6	17.5	21.8
	13.2	12.7	17.7	22.5
	11.7	15.1	17.0	
	12.7			
Avg	13.5	14.4	18.0	24.3